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THE LIFE-HISTORIES OF THE NEW YORK SLUG CATERPILLARS.—II.

PLATE I, FIGS. 1-24.

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Sibine stimulea Clemens.

- 1860.—*Empretia stimulea* CLEMENS, Proc. Acad. Nat. Sci. Phila. XII, 158.
1862.—*Empretia stimulea* MORRIS, Synop. Lep. 130.
1864.—*Empretia stimulea* PACKARD, Proc. Ent. Soc. Phila. III, 340.
1869.—*Limacodes ephippiatus* HARRIS, Corresp. p. 361, pl. 1, fig. 7.
1890.—*Empretia stimulea* PACKARD, 5th Rept. U. S. Ent. Com. 147.
1892.—*Empretia stimulea* KIRBY, Syn. Cat. Lep. Het. I, 539.
1892.—*Sibine ephippiatus* KIRBY, Syn. Cat. Lep. Het. I, 540.
1894.—*Sibine stimulea* NEUMOEGEN and DYAR, Journ. N. Y. Ent. Soc. II, 72.

LARVA.

- 1860.—Clemens, Proc. Acad. Nat. Sci. Phila. 159.
1869.—Harris, Corresp. p. 175, pl. 2, figs. 10, 11.
1869.—Packard, Guide Stud. Ins. 289.
1876.—Wetherby, Cincin. Journ. Sci. II, 369.
1877.—French, Trans. Dept. Agr. Ill. XV, 187.
1883.—Saunders, Ins. Inj. Fruits, 113.
1885.—Hubbard, Ins. Aff. Orange, 142.
1888.—Beutenmüller, Ent. Amer. IV, 75 (Food Plants).
1890.—Packard, 5th Rept. U. S. Ent. Comm. p. 146, fig. 50; p. 424 (Food Plants).
1893.—Packard, Proc. Am. Phil. Soc. XXXI, 85, pl. I, figs. 1-3 (egg larval stages).
1894.—Dyar, Ann. N. Y. Acad. Sci. VIII, 216.
1895.—Comstock, Manual Stud. Ins. 225, fig. 246.

SPECIAL STRUCTURAL CHARACTERS.

Dorsal and lateral spaces broad, subventral space narrow, contracted. Ridges very slight, the subdorsal indicated only by the change in direction in the slope of the body, lateral and subventral ridges more distinct, approximate. The ancestral warts converted into fleshy horn-like processes, unequally elongated; in stage I bearing a few slender setæ (Plate I, fig. 1); after the first molt, the subdorsal and lateral rows covered with numerous urticating spines, the subventral row rudimentary, represented by two weak setæ. Of the subdorsal row, the "horns" on joints 3 to 5 and 11 to 13 are distinct, those on joints 6 to 10 rudimentary, but a seta is present even in the last stage. Of the lateral row, the one on joint 5 is absent.

Depressed areas very feebly developed, only their glandular centers distinguishable as slight pits, partially free from skin spines; the dorsal row (1) consequently paired, the addorsal row (2) still slighter, only distinguishable on certain segments or at favorable times, such as just before a molt. Of the lateral rows, the lateral (4) and lower inter-segmental lateral (6) can be made out as slight pits. No others visible. In the contracted subventral space, the two large rows (7 and 8) appear as faint glandular dots, nearly in line. Skin at first smooth, in the later stages finely spinulose.

At the last molt, besides certain changes in color, the length of the "horns" is markedly reduced and their skin-spines shortened. Certain highly modified, easily detachable skin-spines appear, the shorter ones, designated "caltropes" by Dr. Packard, occur in patches at the ends of the horns of the lateral row on joints 6 to 11; the long ones arise from four circular areas of the skin at the posterior end of the body between the terminal horns, and correspond to the caltrops of the lateral horn of joint 12 and the subdorsal one of joint 13, which bear the true caltrops in the lower forms of our "larvæ of type 2."

The coloration is bright and conspicuous, being probably of a warning nature connected with the defensive armor. It is of a peculiar and striking pattern, which doubtless aids in the effect produced.

The larva is a generalized one in the slight degree of retraction of joint 2; the presence of many-spined warts; the slightly marked ridges and poorly developed skin structure. It is specialized in the unequal degree of prolongation of the warts on the several segments, the wart of the lateral row on joint 5 being entirely suppressed, while the spiracle on that segment is moved up out of line with the others; in the

conversion of the primitive setæ into urticating spines on the two upper rows of warts and in the development of certain detachable specialized skin spines in the last stage.*

AFFINITIES, HABITS, ETC.

The genus *Sibine* contains but one species in North America, north of Mexico, though represented by several in Central and South America, with most interesting larvae, to judge by Sepp's figures. Our larva is nearly allied to *Euclea*, *Adoneta* and *Parasa*, possessing in common with them most of the special structural characters described above. It is the most specialized larva of its group ("type 2"). This is one of our most common species of Eucleidæ, and has a wide range of food plants; basswood, cherry, chestnut, oak, corn leaves and *Canna indica* being a few among its many favorites. The young larvæ feed indifferently on the upper or underside of the leaf, consuming all but a thin skin, and unlike *y-inversa*, feeding around themselves, leaving irregular patches on the surface where they have fed (Plate I, fig. 21) until they reach the third stage, when the whole leaf is devoured in large holes, either on the edge or in the body of the leaf.

The species is single brooded, the moths (Plate I, fig. 15) appearing in July. The males fly, seeking their mates in the early twilight, and on favorable nights (warm and damp with a slight breeze) come in swarms to the cages, their wings fluttering and dancing rapidly over the surface of the gauze wire, where the females are confined, or darting in circles about the cages seeking an entrance. The couples remain paired usually until the same hour the next evening, though occasionally they separate earlier. The females lay their eggs during the night, in patches of from thirty to fifty, on the upper side of the leaf. The eggs hatch in ten days, but the larvæ develop slowly, maturing in September or even not until October. The larva of *stimulea* is well known for its stinging properties; the nettle-like spines being capable of inflict-

* We conceive the "caltropes" (Plate I, fig. 5) to be modified skin spines and the long spines (Plate I, fig. 7) to be modified "caltropes." We trace the following series. In *Euclea indetermina* there are no detachable spine patches, but only "caltropes." *E. pænulata (elliottii)* has one pair of patches; *E. delphinii* two pairs, but smaller and less developed than in *Sibine*. The spines also are smaller and have a swollen base, looking like elongate "caltropes." We expect to figure them when we reach *Euclea*. The caltropes are about the same size in all (0.068 mm.), but the spines become larger as they are better developed. In *pænulata* their length is 0.28 mm.; in *delphinii*, 0.56 mm. and in *stimulea* 0.89.

ing quite a severe pain and retaining this power even when spun into the cocoon.

CRITICISMS OF PREVIOUS DESCRIPTIONS.

We have given a list of eleven descriptions or figures of this larva. All but one of them treat of the general characters of the larva, principally the mature larva. Harris' figures are probably the best, though far from exact. Dr. A. S. Packard in 1893 gave the first account of the life history, though but partially, with figures of structural details. His figure of stage I is incorrect in two respects. He represents three rows of tubercles on joints 3 to 5, where there are but two, and shows the spiracle on joint 5 in line with the others with a tubercle above it, whereas there is really no tubercle there and the spiracle is not in line (compare our figure, Plate I, fig. 1). Dr. Packard has well figured the principal other structural elements except the long detachable spines (Plate I, fig. 7). These are one of the most noticeable elements; but we have seen no exact published account of them. Harris calls them "deep purplish red, velvet-like spots;" Packard mentions them as "a pair of rust brown flattened branches of singular spinules" and Dyar refers briefly to an "elevated brown structure like many spines close together" in his general description of the mature larva. The Rev. J. L. Zabriskie has exhibited preparations of these spines to the New York Entomological Society, but the minutes of the meeting have not been published.

Dr. Packard describes the several stages as if there were but five. He appears to have had stage I, stage IV toward the end of the stage, stage V (described twice) and stage VIII, the last; but he has numbered them consecutively.

Mr. Dyar, in his description of the mature larva, has referred, by error, the last two horns of the subdorsal row to the lateral row, which causes him to speak of "an extra pair at the anus" and to locate the spine patches wrongly.

DESCRIPTION OF THE SEVERAL STAGES IN DETAIL.

Egg.—(Plate I, fig. 20). Elliptical, very flat, almost as thin as paper, thin shelled, laid in a mass of fifty or more, imbricate in alternating rows like shingles on a roof, neatly and regularly set. Transparent, yellowish, clear, the shell covered with neat irregularly hexagonal, pentagonal or even quadrangular reticulate opaque lines; rarely one of these cell areas is circular. The lines are narrow, not perceptibly

raised, but very distinct. Surface smooth and level, or a little grooved longitudinally from shrinking. Dimensions 1.8 x 1.2 x 0.1 mm.

The embryo lies curled on its side, the head and tail touching, greatly flattened laterally. Before hatching it shortens and thickens, the egg swells up so as to be much higher than before and the larva emerges through a small hole which it eats in the shell.

Stage I.—(Plate I, fig. 1). Shape essentially as in the mature larva. The horns only grow a little after hatching, being distinct before. Tubercles of the subdorsal row (tubercles i+ii), of lateral row (iii), each with three setæ, all raised on conical projections of the body (Plate I, fig. 3) forming horns; those on joints 3, 4, 5, 11 and 12 of the subdorsal row about twice as long as the others. Lateral row on joints 3, 4, 6, to 12, subequal. Subventral row represented by small setæ. Joint 2 not retracted below joint 3 even when walking, setiferous. Cuticle smooth, without spines. Color entirely light yellow, without marks, the horns a little whitish. Head concolorous with the body, clear yellow; ocelli brown; width .3 mm. (calculated .25 mm.). Length on hatching 1.3 mm.

The larvæ do not feed in this stage, but after hatching and eating a portion of the shell become quiescent and molt in two days.

Stage II.—Horns densely spined with many sharp stiff bristles, as in the mature larva (Plate I, fig. 4). The subdorsal on joints 3 to 5, 11 and 12 longer than the others, but rather shorter conic than before; joints 6 to 10 with only one or two short setæ, the tubercles rudimentary. Lateral row moderately developed on joints 3 and 4, smaller on joints 6 to 12, the spines less numerous than on the subdorsal horns, some of them hair-like. Spiracles moderately distinct, arranged as in the figure of stage I. Color whitish yellow without marks. Segments distinct, skin smooth, with just an indication of granulations. Magnified 350 diameters, this appears as an irregular puncturing or confused shagreen of the surface, but indistinct. Joint 2, as in the previous stage. Head pale yellow, ocelli black, mouth brown; width .4 mm. (calculated .35 mm.). Cervical shield is distinct, dark, bisected, level with the skin. Toward the end of the stage, a whitish line appears along the subdorsal ridge, defined by black dots inwardly and a black line outwardly on joints 6 to 10; the horns become shaded with blackish, and the space between them crossed by transverse lines. Length of the larva, 1.3 to 2 mm.

Stage III.—(Plate I, fig. 2, diagram of the markings). Elliptical, highest through joints 4 and 5, diminishing posteriorly; ridges not

sharp, all rounded; subdorsal processes fleshy, hornlike, those on joints 3, 4, 5, 11 and 12 long, densely spined, on joints 7, 8 and 9 very short, consisting of a wart with three or four spines, rudimentary on joints 6 and 10, short on joint 13. Lateral row on joints 3, 4, 6 to 12, moderate, spined, those on joints 3 and 4 slightly larger than the others: on joint 13 a few spines. Subventral edge scarcely ridged, setiferous. Skin closely covered with minute spinulose granules, close set, without tubercular bases, a little sunken in places corresponding to the usual depressed areas, especially in the dorsal intersegmental ones, but obscurely, and the areas are scarcely distinguishable. The color is subject to some variation in different examples. When well developed, the color is light green, the horns translucent whitish, except the subdorsal on joint 4 which has a faint vinous tinge, on joint 5 dark purplish vinous, and on joint 11 pale purple. A wavy black subdorsal line, the pair connected by shaded streaks over the dorsum on joints 3, 4, 5 and 11, about two on each segment, leaving square or rounded patches of the ground color between the pairs of horns, that on joint 5 distinctly round. Subdorsal band broken on joints 6 to 10 (Plate I, fig. 2) and on joints 7 to 9 bordered above by a white band, the dorsal space here filled in with a blackish shade, which forms an elongated patch. Posterior end of the body and lateral region immaculate. Head green, shaded with brownish below, eyes black; width .5 mm. Length of the larva 2 to 3 mm.

Stage IV.—Essentially as before, the markings better defined. Dorsal intersegmental depressions small, paired, or single next to the large horns, at the base of which is indicated a paired addorsal segmental row. Horns of both rows on joints 3 and 4 pale flesh pink, the subdorsal on joints 5 and 11 purple, on joint 12 yellowish, the rest nearly colorless. Dorsal and lateral region of joints 3 to 5 and dorsal region of joint 11 purple, except the small paired greenish impressed spots and an unpaired median oval yellow one on joints 5 and 11. Dorsal patch on joints 7 to 9 blackish, bordered with white at the sides and below by a wavy line. This white and black marking is repeated around the rudimental subdorsal tubercle on joints 6 and 10, closely approximated to the adjacent large horn. Ground color of the dorsum green, replaced by yellow on joints 5, 6, 10 and 11; lateral region whitish. An elliptical white spot subdorsally between the horns of joints 11 and 12. The spines on the horns and skin spinules essentially as in the mature larva, the latter passing on to the horns where they become elongated into short spines. Width of the head .7 mm. (calculated .72 mm.). Length of the larva 3 to 5.5 mm.

Stage V.—Horns shorter than before at first, but they grow considerably during the stage, spines longer; the rudimentary horns on joints 6 to 10 smaller. Armature essentially as before. Color essentially the same. Horns on joints 3 and 4 flesh-colored, subdorsal on joints 5 and 11 dark purple brown, this color covering joints 3 to 5 as far as the lateral horns and joint 11 below the subdorsal horn and the dorsal patch on joints 7 to 9, which is bordered as before. A yellow dorsal spot between joints 6 and 7, and 9 and 10; a distinct round yellow dorsal spot on joints 5 and 12, a white subdorsal patch on joint 12 as before. The rest of the dorsal and lateral areas bright yellowish green, the lateral ridge and subventral area colorless. Two intersegmental lateral depressions can now be distinguished beside the dorsal ones. Subdorsal horns on joints 12 and 13 colorless like the lateral ones, above which a straight white line is separated from the green lateral area by a dark transparent line. A faint white line on the subventral ridge. Width of the head 1 mm.; length of the larva 5.5 to 9.5 mm.

Stage VI.—(Plate I, figs. 17 and 18). Similar to the preceding. Patches over the large horns and adjacent, brown, shading darker at the edges; the anterior one covering the lateral horns, the posterior the subdorsal horns on joint 11 and surrounding the white patch between joints 11 and 12; a small dorsal linear spot on joint 4, a round one on joints 5 and 11, yellow. Green dorsal blanket-like patch reaches to the lateral horns extending over joints 6 to 10 and running back laterally beneath the subdorsal horns to end in a point on joint 12. It is edged with black and white in the following manner: A subdorsal crimson brown dash on joints 6 and 10, a dusky band above the lateral horn; central elliptical patch crimson brown, blackish at the edge, then crimson, bordered with white and laterally by a crimson brown line. Between the subdorsal horns of joints 11 and 12 a large rounded pentagonal white spot. Horns on joints 3 and 4 fleshy brown, the subdorsal on joints 5 and 11 purplish brown, 3.5 to 6 mm. long, the rest colorless. Body rounded rectangular in dorsal aspect, the ends larger than the middle; subdorsal ridge evenly rounded over, lateral ridge prominent, subventral space very small, colorless, a white line along the subventral edge. Depressed areas very small, forming slight hollows, the dorsal and two lateral intersegmental rows present, the rest not distinguishable. Skin smooth to the naked eye, under a strong lens seen to be densely covered with pointed conical skin spines, dark or colorless according to the ground color, elongated on the horns. Spines stiff, straight and smooth, black tipped, reddish on the long horns, colorless

on the short ones. Width of the head 1.4 mm. (calculated 1.47). Length of the larva 9.5 to 13 mm.

Stage VII.—As in the preceding stage. Stage VII differs from the last stage (VIII) as follows: The horns are longer (compare figs. 10 and 9) and their skin spines shorter (Plate I, figs. 22 and 13). The purple brown color is less extensive, being absent from the subventral area and the posterior end of the body, confined to the regions described above, and its tint is rather paler. The patches of "caltrope" spines are present, but smaller than in the last stage and there are no tufts of detachable spines. The long horns grow from 3.5 mm. to 5.8 mm. during the stage and are suddenly shortened to about 2 mm. at the last molt. Width of the head 2 mm.; length of the larva 13 to 18 mm.

Stage VIII.—(Plate I, fig. 16). Head beneath joint 2, but 2 not beneath 3; joints 3 and 4 somewhat folded. Dorsum rises nearly perpendicularly in front, rounds over at joint 5, slopes gently and slightly to joint 11, and is then nearly perpendicular to the anus. No subdorsal ridge, the body evenly rounded, the sides almost perpendicular. On joints 3, 4, 5 and 11 a pair of suborsal fleshy processes, furnished with long stiff spines, salmon colored with black tip (Plate I, fig. 4); among them a very few spatulate setae (Plate I, fig. 14). The processes on joints 3 and 4 are short, those on joints 5 and 11 long (2 to 3.5 mm.), on joint 12 small and still smaller on joint 13. A similar lateral row on joints 3, 4, 6 to 12, all short. On joint 12, above the lateral process, and on 13 anterior to it, is an elevated velvety brown spot, composed of closely set, detachable spines (Plate I, figs. 7, 23 and 24; fig. 8 shows the appearance of the skin after these spines are detached). These spines have a pale yellowish shaft and brown-black tip. Body smooth to the naked eye, under a lens finely spinulose (Plate I, figs. 11, 12 and 13) with paired dorsal and two lateral rows of intersegmental shallow pale-colored pits. Color dark purplish vinous; a pale yellow, elliptical spot dorsally on joints 5 and 11, edged with blackish; a much larger similarly colored one on each side subdorsally behind the large horn on joint 11; a large bright green patch covers the back and sides of joints 6 to 10 like a blanket, extending on joints 11 and 12 laterally, and leaving an elliptical patch of the ground color dorsally on joints 7 to 9 like a hole in the blanket. The blanket patch is narrowly edged with black and broadly with white. Head pale greenish, eyes black, mouth brown; width 3 mm. The anterior edge of joint 2 bears many setae, and there is a group of them before the spiracle. Cervical shield a skinny area with a few punctures on its anterior border, square behind,

the anterior corners cut off, 2 mm. wide. A fold runs across joint 2 obliquely from the anterior corner of the cervical shield backward above the spiracle. Two hairs subventrally (iv + v) on every segment except joint 2. Thoracic feet small, colorless, with a terminal brown claw. About eight setae on the suranal lobe and seven on each paranal lobe, the latter not different from those just assigned to the subventral row. Subdorsal tubercules represented by tiny spines on joints 6 to 10, as in the previous stage. On the upper side of the lateral horns on joints 6 to 11, near the tip, are a series of patches of minute detachable spines, designated "caltropes" by Dr. Packard. (Plate I, fig. 5.) A few are also found among the detachable spines at the end of the body, but of a somewhat different shape. (Plate I, fig. 6.) The length of these "caltropes" is about .07 mm. Length of the larva 16 to 23 mm.

Cocoon.—(Plate I, fig. 19). With the characters of the group.

EXPLANATION OF PLATE I.

(*Sibine stimulea*.)

1. Larva in stage I, enlarged.
 2. End of stage III, a diagram showing the genesis of the markings of the central dorsal area.
 3. A horn of stage I, 175 diameters.
 4. A permanent spine (seta) of a long horn $\times 50$.
 5. A "caltrope" from a lateral horn $\times 175$.
 6. A "caltrope" from among the detachable spines $\times 175$.
 7. A detachable spine $\times 50$.
 8. Skin after the removal of the detachable spines $\times 175$.
 9. Diagram of front view of larva, stage VIII.
 10. Diagram of front view of larva, stage VII.
 11. A seta of the rudimentary subdorsal horn of joint 8 with the adjacent skin spines $\times 50$.
 12. The same region $\times 175$, showing the skin spines enlarged.
 13. The skin spines on a horn $\times 175$.
 14. A solitary spatulate seta from the end of the subdorsal horn of joint 5 $\times 175$.
 15. *Sibine stimulea*.
 16. Mature larva.
 17. Larva stage VI, natural size.
 18. The same, dorsal view.
 19. Cocoon.
 20. A group of eggs as laid on the leaf.
 21. Feeding traces of the larva at the first period of eating.
 22. The skin spines on a horn, penultimate stage $\times 175$.
 - 23, 24. Base and apex $\times 175$ of the spine shown in fig. 7.
- Figures 15 to 21 by Miss Morton, the rest by Dr. Dyar.